SLVS602-MARCH 2006

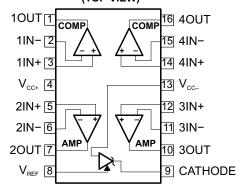
FEATURES

- OPERATIONAL AMPLIFIERS
 - Low Supply Current...200 μ A/A
 - Medium Speed...2.1 MHz
 - Low-Level Output Voltage Close to V_{CC-} ...0.1 V Typ ($R_L = 10 \text{ k}\Omega$)
 - Input Common-Mode Voltage Range Includes Ground
- COMPARATORS
 - Low Supply Current...200 μA/A (V_{CC} = 5 V)
 - Input Common-Mode Voltage Range Includes Ground
 - Low Output Saturation Voltage...
 Typically 250 mV (I_{sink} = 4 mA)
- VOLTAGE REFERENCE
 - Adjustable Output Voltage...V_{REF} to 36 V
 - Sink Current Capability...1 mA to 100 mA
 - 0.4% (A Grade) and 1% (Standard Grade)
 Precision
 - Latch-Up Immunity

APPLICATIONS

- Switch-Mode Power Supplies
- Battery Chargers
- Voltage and Current Sensing
- Power-Good, Overvoltage, Undervoltage, Overcurrent Detection
- Window Comparators
- Alarms, Detectors, and Sensors

D (SOIC) OR PW (TSSOP) PACKAGE (TOP VIEW)



DESCRIPTION/ORDERING INFORMATION

The TSM102 and TMS102A combine the building blocks of a dual operational amplifier, a dual comparator, and a precision voltage reference, all of which often are used to implement a wide variety of power-management functions, including overcurrent detection, undervoltage/overvoltage detection, power-good detection, window comparators, error amplifiers, etc. Additional applications include alarm and detector/sensor applications.

The TSM102A offers a tight V_{REF} tolerance of 0.4% at 25°C. The TSM102 and TSM102A are characterized for operation from -40°C to 85°C.

ORDERING INFORMATION

T _A	MAX V _{REF} TOLERANCE (25°C)	PACKAGE ⁽¹⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING	
		SOIC - D	Tube of 75	TSM102AID	TSM102AI	
	A grade:	201C – D	Reel of 2500	TSM102AIDR	TSWIUZAI	
	0.4% precision	TSSOP – PW	Tube of 90	TSM102AIPW	SN102AI	
-40°C to 85°C		1330P – PW	Reel of 2000	TSM102AIPWR	SINTUZAI	
-40 C to 65 C		SOIC - D	Tube of 75	TSM102ID	TCM400L	
	Standard grade:	201C – D	Reel of 2500	TSM102IDR	TSM102I	
	1% precision	TSSOP – PW	Tube of 90	TSM102IPW	CNI400I	
		1330F - FW	Reel of 2000	TSM102IPWR	- SN102I	

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

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Absolute Maximum Ratings⁽¹⁾

over free-air temperature range (unless otherwise noted)

			MIN	MAX	UNIT
V_{CC}	Supply voltage			36	V
V_{ID}	Input differential voltage			36	V
VI	Input voltage range		-0.3	36	V
I _{KA}	Voltage reference cathode current			100	mA
0	Package thermal impedance (2)(3)	D package		73	°C/W
θ_{JA}	Package thermal impedance ⁽²⁾⁽³⁾	PW package		108	
T_{J}	Maximum junction temperature			150	°C
T _{stg}	Storage temperature range		-65	150	°C

Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Recommended Operating Conditions

		MIN	MAX	UNIT
V _{CC+} - V _{CC-}	Supply voltage	3	30	V
V _{ID}	Comparator differential input voltage		V _{CC+} – V _{CC}	V
V _{KA}	Cathode-to-anode voltage	V_{REF}	36	V
I _K	Reference cathode current	1	100	mA
T _A	Operating free-air temperature	-40	85	°C

Total Device Electrical Characteristics

	PARAMETER	TEST CONDITIONS	TA	MIN	TYP	MAX	UNIT
	Total supply current,	V - 5 V V - 0 V No load	25°C		0.8	1.5	m ^
ıc	excluding reference cathode current	$V_{CC+} = 5 \text{ V}, V_{CC-} = 0 \text{ V}, \text{ No load}$	Full range			2	mA

Maximum power dissipation is a function of $T_J(max)$, θ_{JA} , and T_A . The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) - T_A)/\theta_{JA}$. Selecting the maximum of 150°C can affect reliability. (3) The package thermal impedance is calculated in accordance with JESD 51-7.



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Operational Amplifier Electrical Characteristics

 $\rm V_{CC+}$ = 5 V, $\rm V_{CC-}$ = GND, R1 connected to $\rm V_{CC}/2$ (unless otherwise noted)

	PARAMETER	TEST CONDITION	IS	T _A	MIN	TYP	MAX	UNIT	
V	lanut effect veltere			25°C		1	4.5	\/	
V _{IO}	Input offset voltage			Full range			6.5	mV	
αV_{IO}	Input offset voltage drift			25°C		10		μV/°C	
	Input offset current			25°C		5	20	nA	
I _{IO}	input onset current		Full range			40	117 \		
	Input bigg gurrent			25°C		20	100	nA	
I _{IB}	Input bias current			Full range			200	nA	
A _{VD} Large-signal voltage gain		$V_{CC+} = 30 \text{ V}, R1 = 10 \text{ k}\Omega,$	25°C	50	100		V/mV		
A_{VD}	Large-Signal voltage gain	$V_0 = 5 \text{ V to } 25 \text{ V}$		Full range	25			V/IIIV	
k _{SVR}	Supply-voltage rejection ratio	$V_{CC+} = 5 \text{ V to } 30 \text{ V}$		25°C	80	100		dB	
V	Input common-mode voltage			25°C	V _{CC} -		$V_{CC+} - 1.8$	V	
V _{ICM}	input common-mode voltage		Full range	V _{CC} -		V _{CC+} – 2.2	V		
CMRR	Common-mode rejection ratio	$V_{CC+} = 30 \text{ V},$ $V_{ICM} = 0 \text{ V to } V_{CC+} - 1.8 \text{ V}$		25°C	70	90		dB	
	Short-circuit current	$V_{ID} = \pm 1 \text{ V}, V_{O} = 2.5 \text{ V}$	Source	25°C	3	6		mΛ	
I _{SC}	Short-circuit current	$v_{\text{ID}} = \pm i v, v_{\text{O}} = 2.5 v$	Sink	25 C	3	6		mA	
V	High lovel output voltage	$V_{CC+} = 30 \text{ V}, R_1 = 10 \text{ k}\Omega$		25°C	27	28		V	
V _{OH}	High-level output voltage	V _{CC+} = 30 V, K _L = 10 K ₂ 2		Full range	26			V	
V	Low-level output voltage	$R_1 = 10 \text{ k}\Omega$		25°C		130	170	mV	
V _{OL}	Low-level output voltage	$R_L = 10 \text{ ksz}$		Full range			200	IIIV	
SR	Slew rate	$V_{CC} = \pm 15 \text{ V}, C_L = 100 \text{ pF}, V_I = \pm 10 \text{ V}, R_L = 10 \text{ k}\Omega$		25°C	1.3	2		V/μs	
GBW	Gain bandwidth product	$R_L = 10 \text{ k}\Omega, C_L = 100 \text{ pF, f}$	= 100 kHz	25°C	1.4	2.1		MHz	
Фт	Phase margin	$R_L = 10 \text{ k}\Omega, C_L = 100 \text{ pF}$		25°C		45		0	
THD	Total harmonic distortion			25°C		0.01		%	
V _n	Equivalent input noise voltage	f = 1 kHz		25°C		19		nV/√ Hz	

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Comparator Electrical Characteristics

 $V_{CC+} = 5 \text{ V}, V_{CC-} = \text{GND} \text{ (unless otherwise noted)}$

	PARAMETER	TEST CONDITIONS	T _A	MIN	TYP	MAX	UNIT	
V	Input offset voltage		25°C			5	mV	
V _{IO}	Input offset voltage		Full range			9	mv	
V _{ID}	Comparator differential input voltage		Full range			V _{CC+}	V	
1	Input offset current		25°C	50			nA	
I _{IO}	input onset current		Full range	Full range		150	IIA	
	Input higo ourrent		25°C			250	nA	
I _{IB}	Input bias current		Full range			400	IIA	
	High lovel output ourrent	V - 1 V V - V - 20 V	25°C		0.1		nA	
I _{ОН}	High-level output current	$V_{ID} = 1 \text{ V}, V_{CC} = V_{O} = 30 \text{ V}$	Full range			1	μΑ	
V	Low lovel cutout voltage	V - 1 V I - 4 mA	25°C		250	400	mV	
V _{OL}	Low-level output voltage	$V_{ID} = -1 V$, $I_{sink} = 4 \text{ mA}$	Full range			700		
A _{VD}	Large-signal voltage gain	$V_{CC+} = 15 \text{ V}, R1 = 15 \text{ k}\Omega, V_{O} = 1 \text{ V to } 11 \text{ V}$	25°C		200		V/mV	
I _{sink}	Output sink current	$V_{O} = 1.5 \text{ V}, V_{ID} = -1 \text{ V}$	25°C	6	16		mA	
V	Input common-mode		25°C	0		V _{CC+} – 1.5	V	
V _{ICM}	voltage range		Full range	0		V _{CC+} – 2	V	
t _{RESP}	Response time ⁽¹⁾	R1 = 5.1 k Ω to V _{CC+} , V _{REF} = 1.4 V	25°C		1.3		μs	
t _{RESP,large}	Large-signal response time	R1 = 5.1 k Ω to V _{CC+} , V _{REF} = 1.4 V, V _I = TTL	25°C		300		ns	

⁽¹⁾ The response-time specification is for 100-mV input step with 5-mV overdrive. For larger overdrive signals, 300 ns can be obtained.



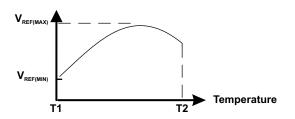
SLVS602-MARCH 2006

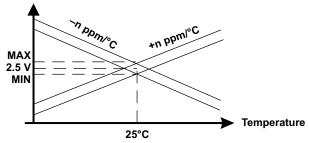
Voltage-Reference Electrical Characteristics

	PARAMETER		TEST CONDITIONS	T _A	MIN	TYP	MAX	UNIT
V	Reference voltage ⁽¹⁾	TSM102	$V_{KA} = V_{REF}$, $I_K = 10$ mA,	25°C	2.475	2.5	2.525	V
V _{REF}	Reference voltage	TSM102A	See Figure 1	25°C	2.49	2.5	2.51	V
ΔV_{REF}	Reference input voltage over temperature range		$V_{KA} = V_{REF}$, $I_K = 10$ mA, See Figure 1	Full range		7	30	mV
$\frac{V_{\text{REF}}}{T}$	Average temperature coefficient of reference input voltage (2)		$V_{KA} = V_{REF}$, $I_K = 10 \text{ mA}$	Full range		±22	±100	ppm/°C
$\frac{V_{REF}}{V_{KA}}$	Ratio of change in reference voltage to change in cathode voltage		$V_{KA} = 3 \text{ V to } 36 \text{ V}, I_{K} = 10 \text{ mA},$ See Figure 2	25°C		-1.1	-2	mV/V
	Deference input current		$I_{K} = 10 \text{ mA}, R1 = 10 \text{ k}\Omega, R2 = \infty,$	25°C		1.5	2.5	^
I _{REF}	Reference input current		See Figure 2	Full range			3	μΑ
ΔI_{REF}	Reference input current over temperature range		I_K = 10 mA, R1 = 10 k Ω , R2 = ∞ , See Figure 2	Full range		0.5	1	μΑ
I _{min}	Minimum cathode curre for regulation	nt	V _{KA} = V _{REF} , See Figure 1	25°C		0.5	1	mA
$I_{K,OFF}$	Off-state cathode currer	nt	See Figure 3	25°C		180	500	nA

(1) ΔV_{REF} is defined as the difference between the maximum and minimum values obtained over the full temperature range. ΔV_{REF} = V_{REF(MAX)} - V_{REF(MIN)}
 (2) The temperature coefficient is defined as the slopes (positive and negative) of the voltage vs temperature limits within which the

reference voltage is specified.







PARAMETER MEASUREMENT INFORMATION

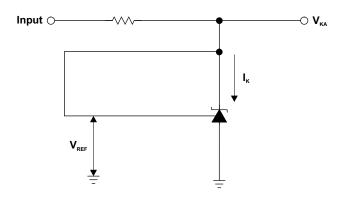


Figure 1. Test Circuit for $V_{KA} = V_{REF}$

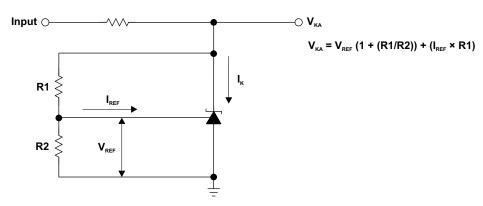


Figure 2. Test Circuit for $V_{KA} > V_{REF}$

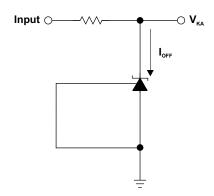
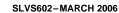


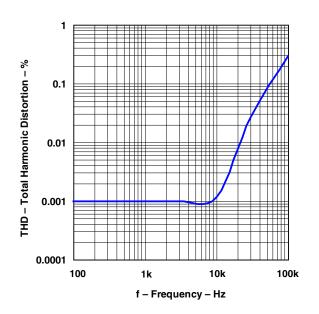
Figure 3. Test Circuit for I_{OFF}





TYPICAL CHARACTERISTICS

AMPLIFIER TOTAL HARMONIC DISTORTION VS FREQUENCY



AMPLIFIER NOISE VOLTAGE VS FREQUENCY

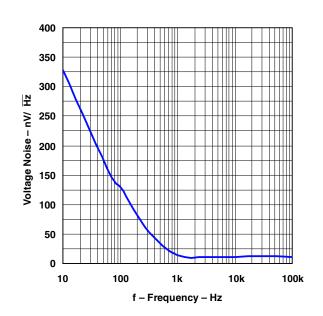
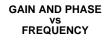


Figure 4.



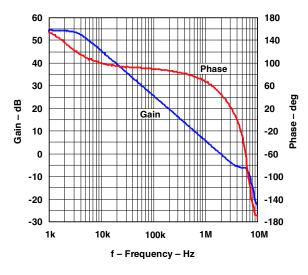


Figure 5.



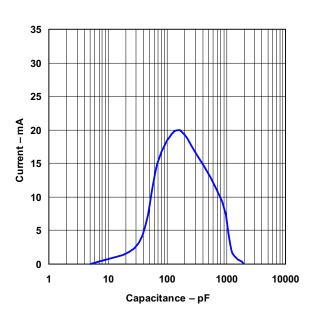
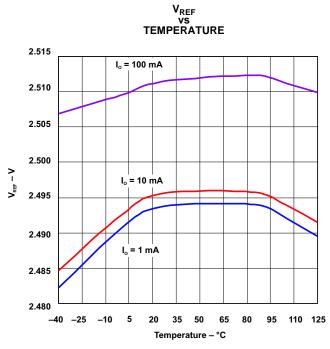


Figure 6.

Figure 7.



TYPICAL CHARACTERISTICS (continued)







10-Jun-2014

PACKAGING INFORMATION

Orderable Device	Status	Package Type	Package Drawing	Pins	Package Qty	Eco Plan	Lead/Ball Finish	MSL Peak Temp	Op Temp (°C)	Device Marking (4/5)	Samples
TSM102AID	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TSM102AI	Samples
TSM102AIDG4	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TSM102AI	Samples
TSM102AIDR	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TSM102AI	Samples
TSM102AIPW	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	SN102AI	Samples
TSM102AIPWR	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	SN102AI	Samples
TSM102AIPWRG4	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	SN102AI	Samples
TSM102ID	ACTIVE	SOIC	D	16	40	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TSM102I	Samples
TSM102IDR	ACTIVE	SOIC	D	16	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	TSM102I	Samples
TSM102IPWR	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	SN102I	Samples

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes. **Pb-Free** (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between

the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.



PACKAGE OPTION ADDENDUM

10-Jun-2014

- (3) MSL, Peak Temp. The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.
- (4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.
- (5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.
- (6) Lead/Ball Finish Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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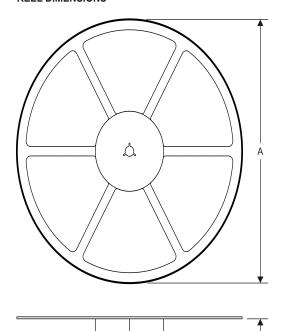
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

PACKAGE MATERIALS INFORMATION

www.ti.com 14-Jul-2012

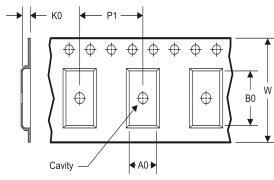
TAPE AND REEL INFORMATION

REEL DIMENSIONS





TAPE DIMENSIONS



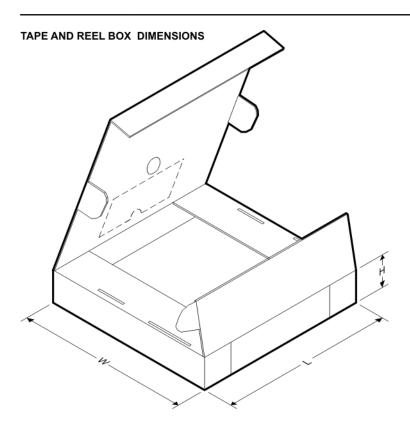
A0	Dimension designed to accommodate the component width
В0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

TAPE AND REEL INFORMATION

*All dimensions are nominal

Device		Package Drawing		SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TSM102AIDR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
TSM102AIPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
TSM102IDR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1
TSM102IPWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1

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*All dimensions are nominal

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Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TSM102AIDR	SOIC	D	16	2500	367.0	367.0	38.0
TSM102AIPWR	TSSOP	PW	16	2000	367.0	367.0	35.0
TSM102IDR	SOIC	D	16	2500	367.0	367.0	38.0
TSM102IPWR	TSSOP	PW	16	2000	367.0	367.0	35.0

D (R-PDS0-G16)

PLASTIC SMALL OUTLINE



- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
- Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
- E. Reference JEDEC MS-012 variation AC.



D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Publication IPC-7351 is recommended for alternate designs.
- D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
- E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.



PW (R-PDSO-G16)

PLASTIC SMALL OUTLINE

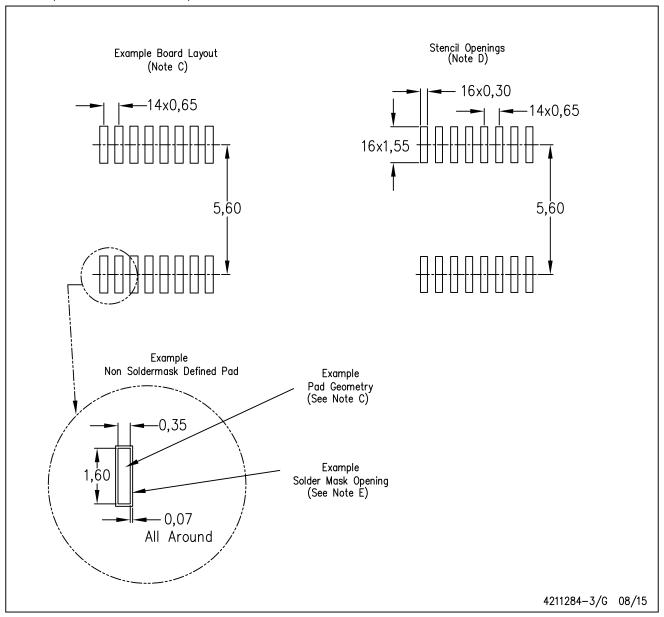


- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M—1994.
- B. This drawing is subject to change without notice.
- Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
- Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
- E. Falls within JEDEC MO-153



PW (R-PDSO-G16)

PLASTIC SMALL OUTLINE



- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Publication IPC-7351 is recommended for alternate designs.
- D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
- E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.



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